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14. ABSTRACT

This project has made several significant contributions in enhancing the energy efficiency, performance and fault-tolerance of computer storage systems. First, we developed Power-Aware Virtual Memory (PAVM) that finds and aggregates unmapped and unused memory pages. By powering down unused memory ranks, we can save a significant amount of energy dissipated by the main memory with virtually no performance degradation. Second, we developed the Free Space File System (FS2) based on the popular Ext2 file system by replicating temporally-related data blocks then using the free disk space to place these blocks closer to one another on the disk and thus allowing the disk heads to move less. This results in higher performance, lower energy consumption and higher fault-tolerance at almost zero cost. Finally, we characterized the disk failure patterns and used it to place replicas of critical information on the disk so as to protect them from common disk failures.
See related publications in http://kabru.eecs.umich.edu, especially http://kabru.eecs.umich.edu//papers/thesis/hai.pdf, for details.

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Executive Summary

This project has made several significant contributions in enhancing the energy efficiency, performance and fault-tolerance of computer storage systems. First, we developed Power-Aware Virtual Memory (PAVM) that finds and aggregates unmapped and unused memory pages. By powering down unused memory ranks, we can save a significant amount of energy dissipated by the main memory with virtually no performance degradation. Second, we developed the Free Space File System (FS2) based on the popular Ext2 file system by replicating temporally-related data blocks then using the free disk space to place these blocks closer to one another on the disk and thus allowing the disk heads to move less. This results in higher performance, lower energy consumption and higher fault-tolerance at almost zero cost. Finally, we characterized the disk failure patterns and used it to place replicas of critical information on the disk so as to protect them from common disk failures.

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Participants

- Kang G. Shin: PI, Kevin & Nancy O'Connor Professor of Computer Science
- Hai Huang: PhD completed in 2006
- Chang-hao (Howard) Tsai: PhD completed in 2009
- Pradeep Padala
- Kai-Yun (Karen) Hou: PhD student

Publications

- Pradeep Padala, Mustafa Uysal, Arif Merchant, Xiaoyun Zhu, Sharad Singhal, and Kang G. Shin, ``Performance differentiation for multi-port arrays: A control-theoretic approach," *Fourth International Workshop on Feedback Control Implementation and Design in Computing Systems and Networks* (FeBID 2009), San Francisco, April 2009.

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- Hai Huang, Kang G. Shin, Charles Lefurgy, and Tom Keller, ``Improving enregy efficiency by making DRAM less randomly accessed," *Proc. Int'l Symposium on Low Power Electronics and Design--2005* (ISLPED'05), San Diego, CA, August 2005.